Appendices

Appendix A

Hydrogeologic Details

- Groundwater Elevations – On-site Monitoring Wells - Table A-1
- Hydrographs – Figures A-1 to A-15
- Groundwater Levels – Residential Water Wells – Table A-2
- Groundwater Levels – Codrington Fish Research Centre – Table A-3

TABLE A-1
GROUNDWATER ELEVATIONS - ON-SITE MONITORING WELLS
CODRINGTON PIT

	BH05-2	BH05-18	BH05-19	BH05-20	BH06-1	BH12-1	BH12-2	CFRC- Well2	CFRC- Well3	CFRC- Well4
Measuring Point	185.72	191.53	185.43	183.59	183.41	204.62	206.39	ND	ND	ND
Ground Elevation	184.78	190.96	184.98	182.81	182.61	203.93	205.47	ND	ND	ND
07-Oct-05	173.87	166.76	159.52	DRY						
20-Oct-05	173.87	166.74	159.53	DRY						
26-Oct-05	173.84	166.69	159.49	DRY						
31-Jan-06	173.60	166.53	159.45	182.04						
23-Mar-06	173.95	166.49	159.38	182.39						
30-Mar-06	173.96	166.52	159.41	182.36	174.77					
21-Apr-06	174.03	166.60	159.44	182.23	174.86					
04-Dec-06	174.04	166.74	159.39	182.54	174.93					
09-Apr-07	174.31	167.03	159.58	182.54	175.13					
09-May-08	174.74	166.78	159.82	182.71	175.62					
24-Mar-10	173.71	166.47			174.67					
18-Aug-11	174.55	167.03			175.12					
16-Nov-12	173.44	166.53	159.74	179.86	174.14					
23-Nov-12						153.52	173.09			
07-Dec-12	173.41	166.54	159.71	178.97	174.10	153.64*	172.74			
11-Apr-13	173.76	167.07	159.40	Ponded	174.53	152.82	173.38	Flowing	1.4	1.94
04-Jul-13	174.21	167.00	159.54	182.54	175.03	152.9	173.90	Flowing	1.4	1.95
19-Sep-13	174.00	166.72	159.62	179.17	174.76	153.42*	173.97	Flowing	1.52	2.06
18-Oct-13							173.87			
04-Dec-13	Damaged	166.79	159.56	181.58	174.40	153.34*	173.69	Flowing	1.55	2.07
15-Apr-14	173.55	166.97	159.4	Ponded	174.57	155.34	173.33	Flowing	1.26	1.82
17-Jun-14	174.56	167.09	159.61	182.82	175.47	152.62	174.20			
15-Sep-14	174.30	166.95	159.82	181.72	175.14	155.21	173.36			
17-Sep-14								Flowing	1.46	1.97
04-Dec-14	173.93	166.76	159.79	181.76	174.73	154.86	174.02			

NOTES:
1) "m asl" indicates metres above sea level.
2) "*" denotes water level based on pressure transducer owing to manual measurement interference by bentonite on well pipe sides.
3) CFRC indicates Codrington Fish Research Centre. No elevation survey of wells, thus depths below top of casing are provided.
4) Blank indicates water level not measured.

FIGURE A-1
GROUNDWATER ELEVATIONS

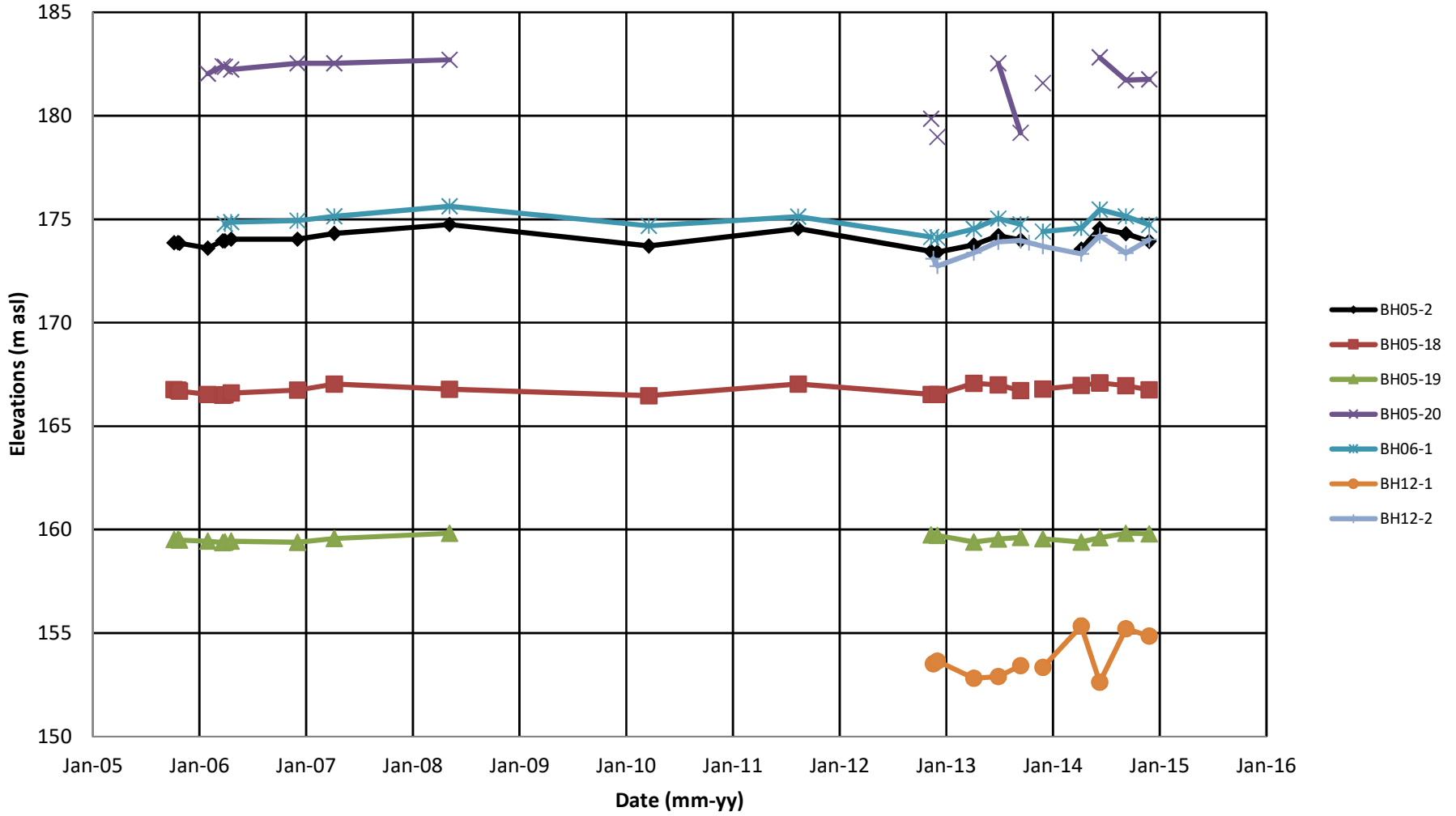


Figure A-2
BH05-2: Groundwater Elevation

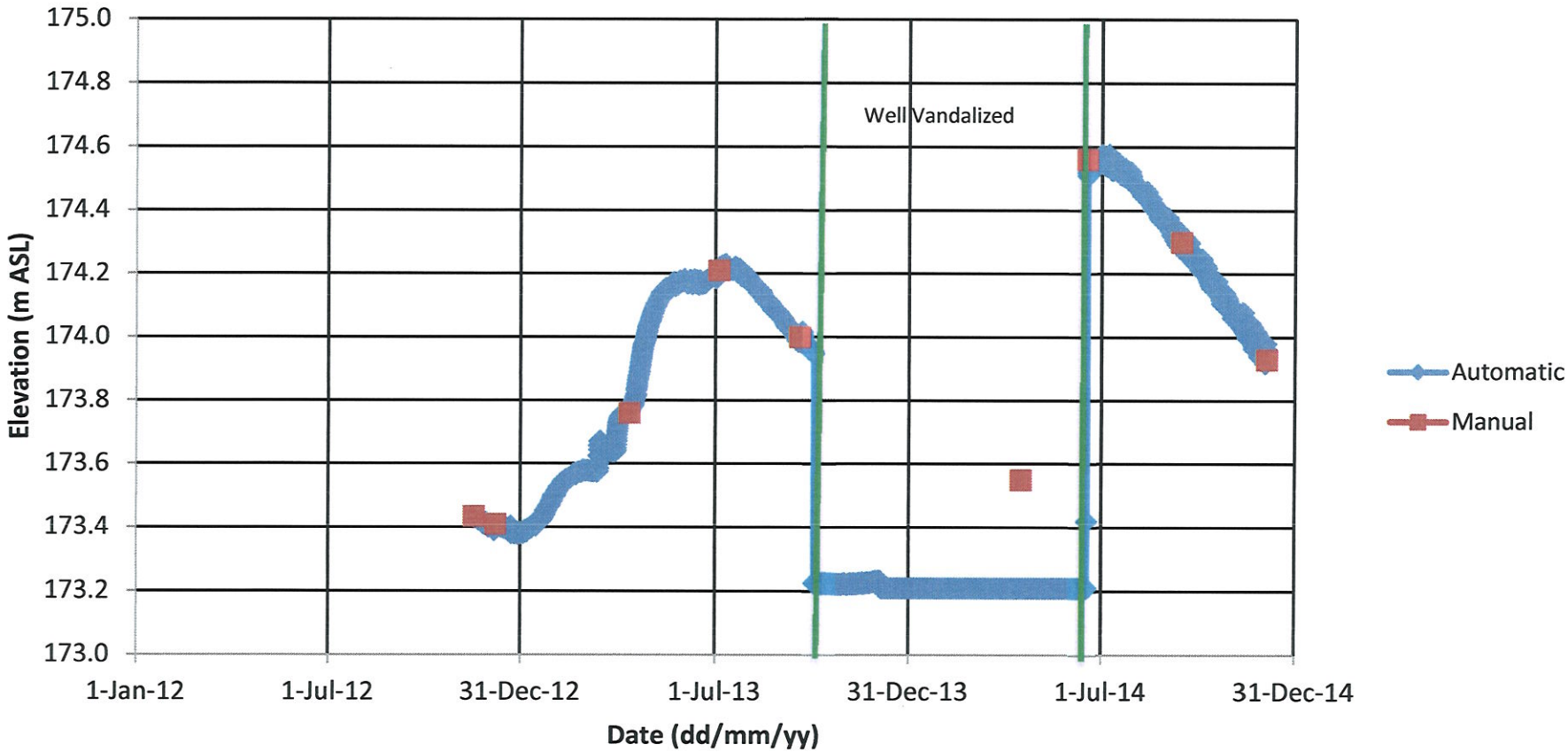


Figure A-3
BH05-2: Groundwater Temperature

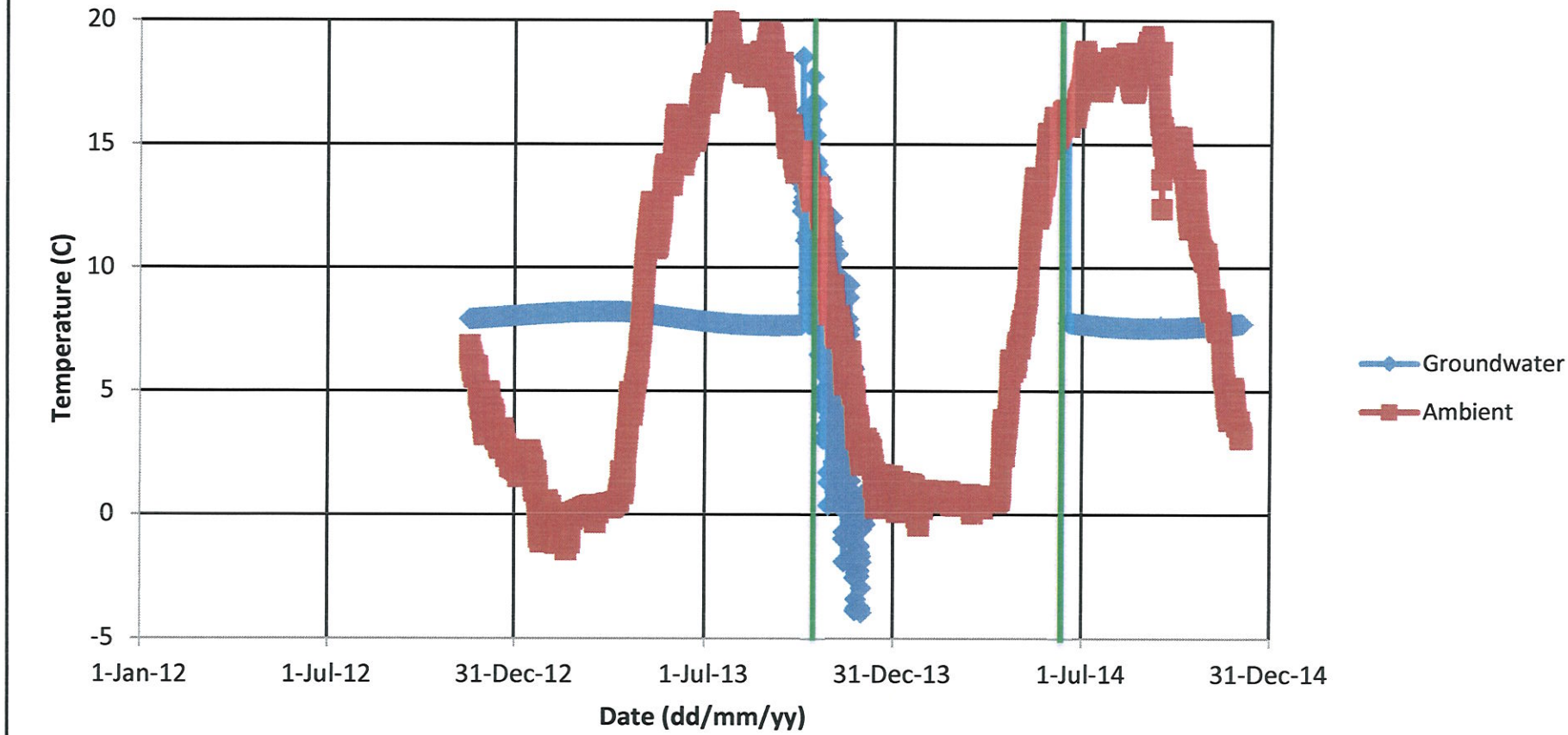


Figure A-4
BH05-18: Groundwater Elevation

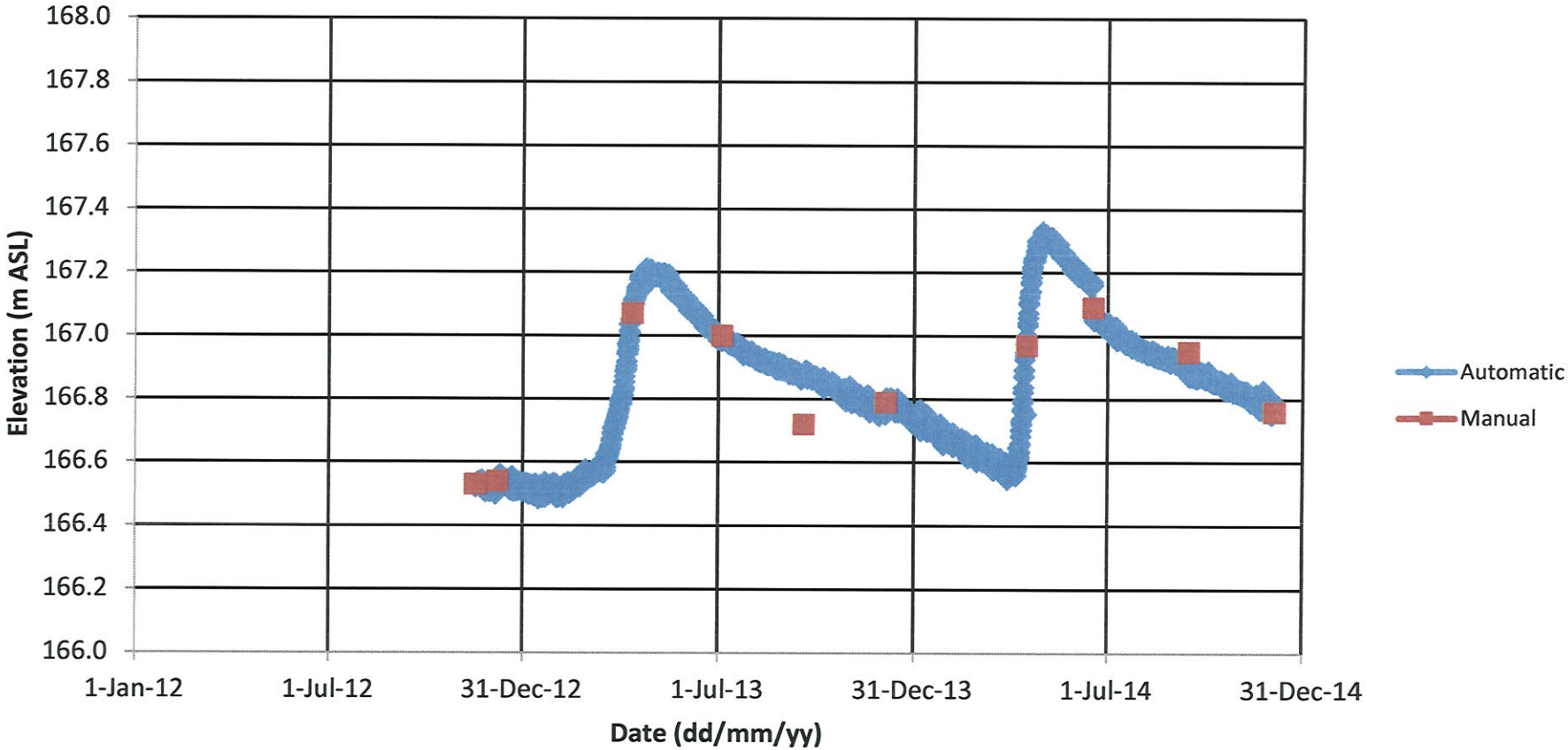


Figure A-5
BH05-18: Groundwater Temperature

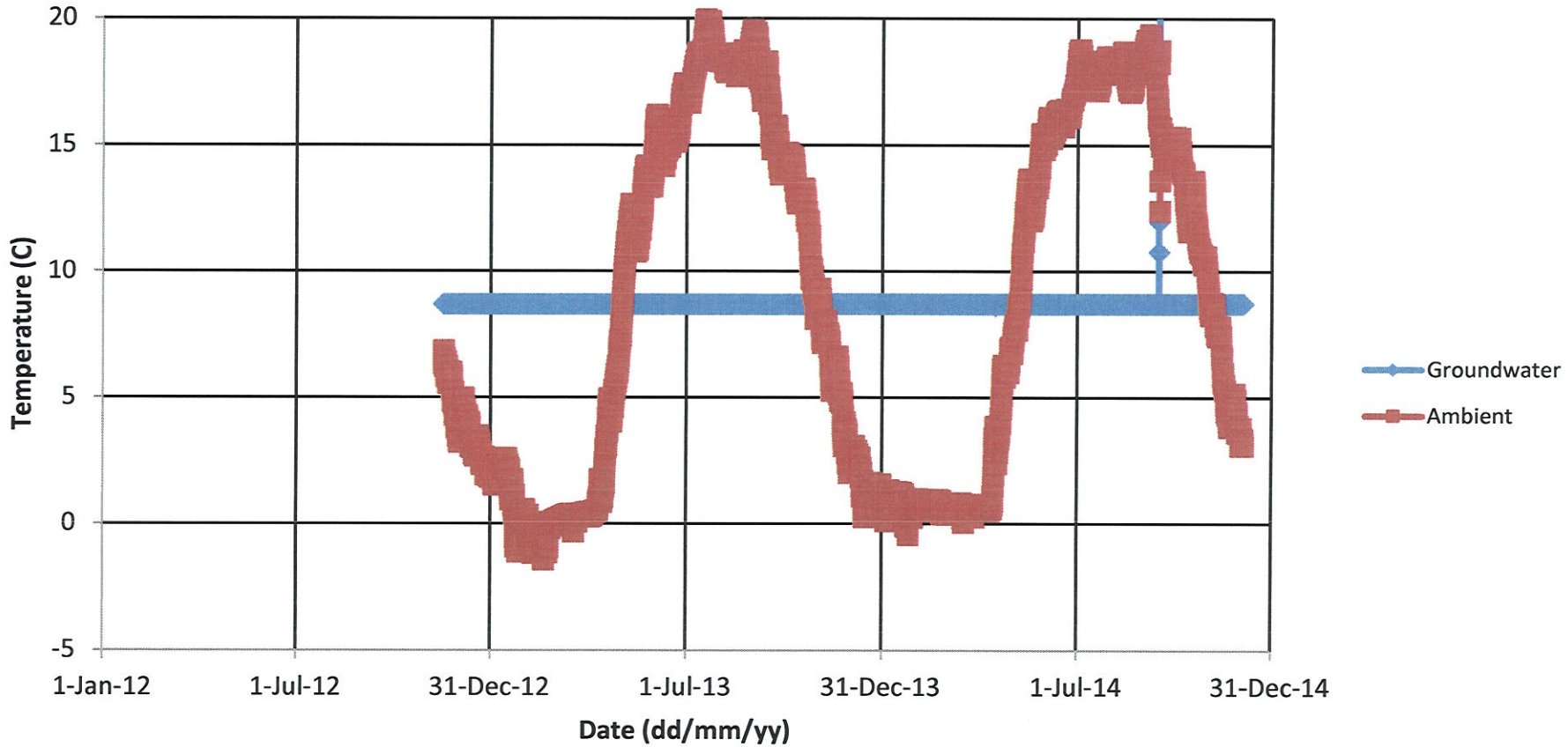


Figure A-6
BH05-19: Groundwater Elevation

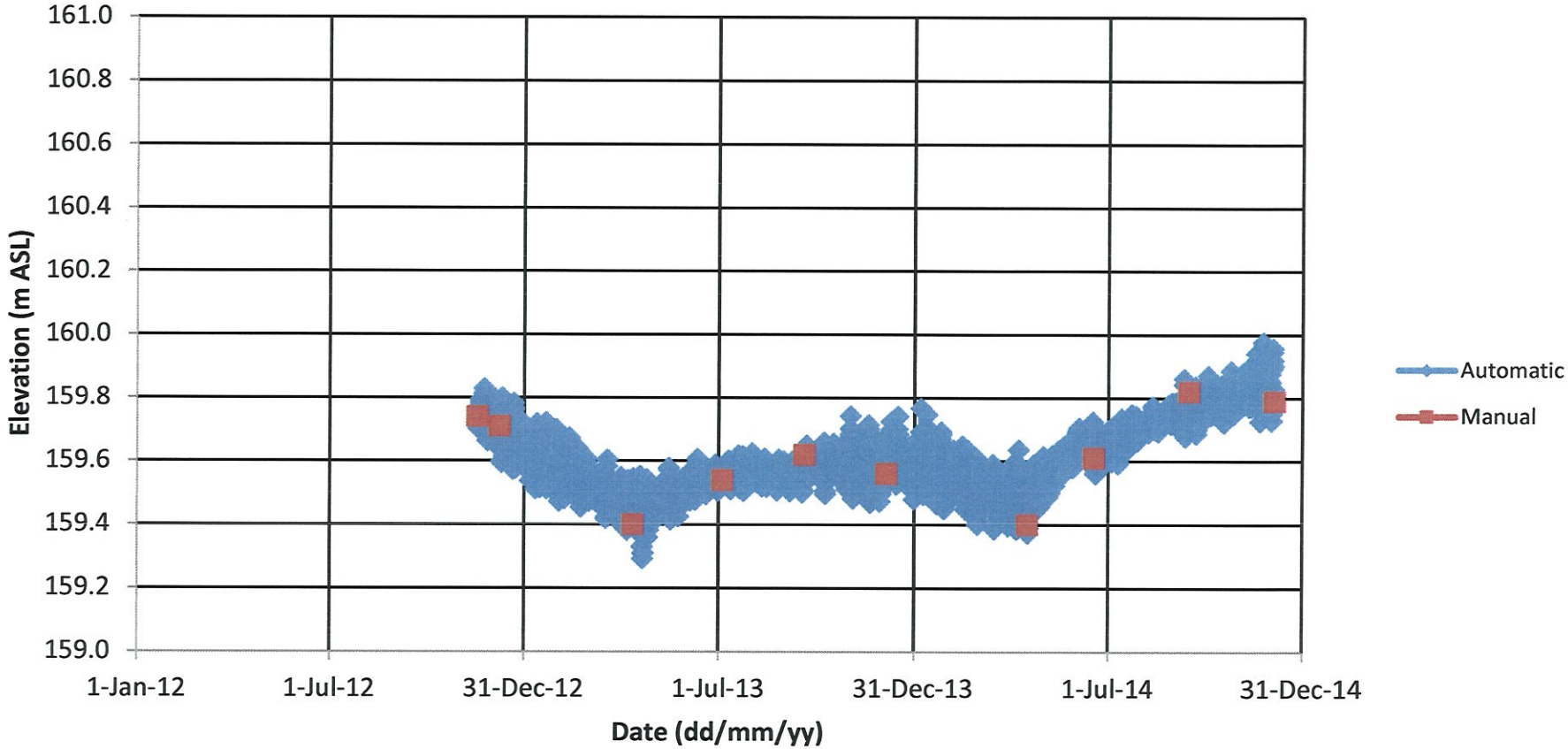


Figure A-7
BH05-19: Groundwater Temperature

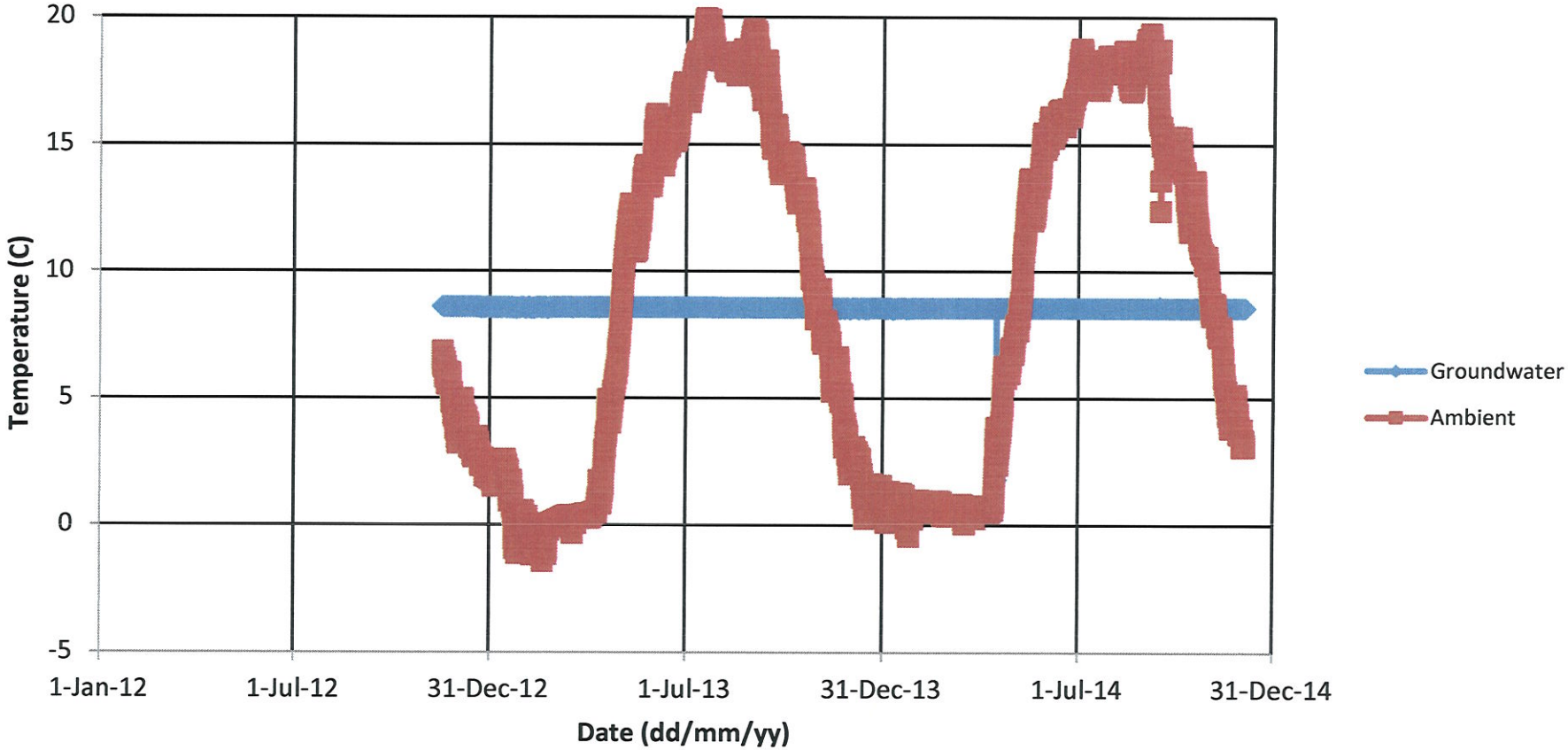


Figure A-8
BH05-20: Groundwater Elevation

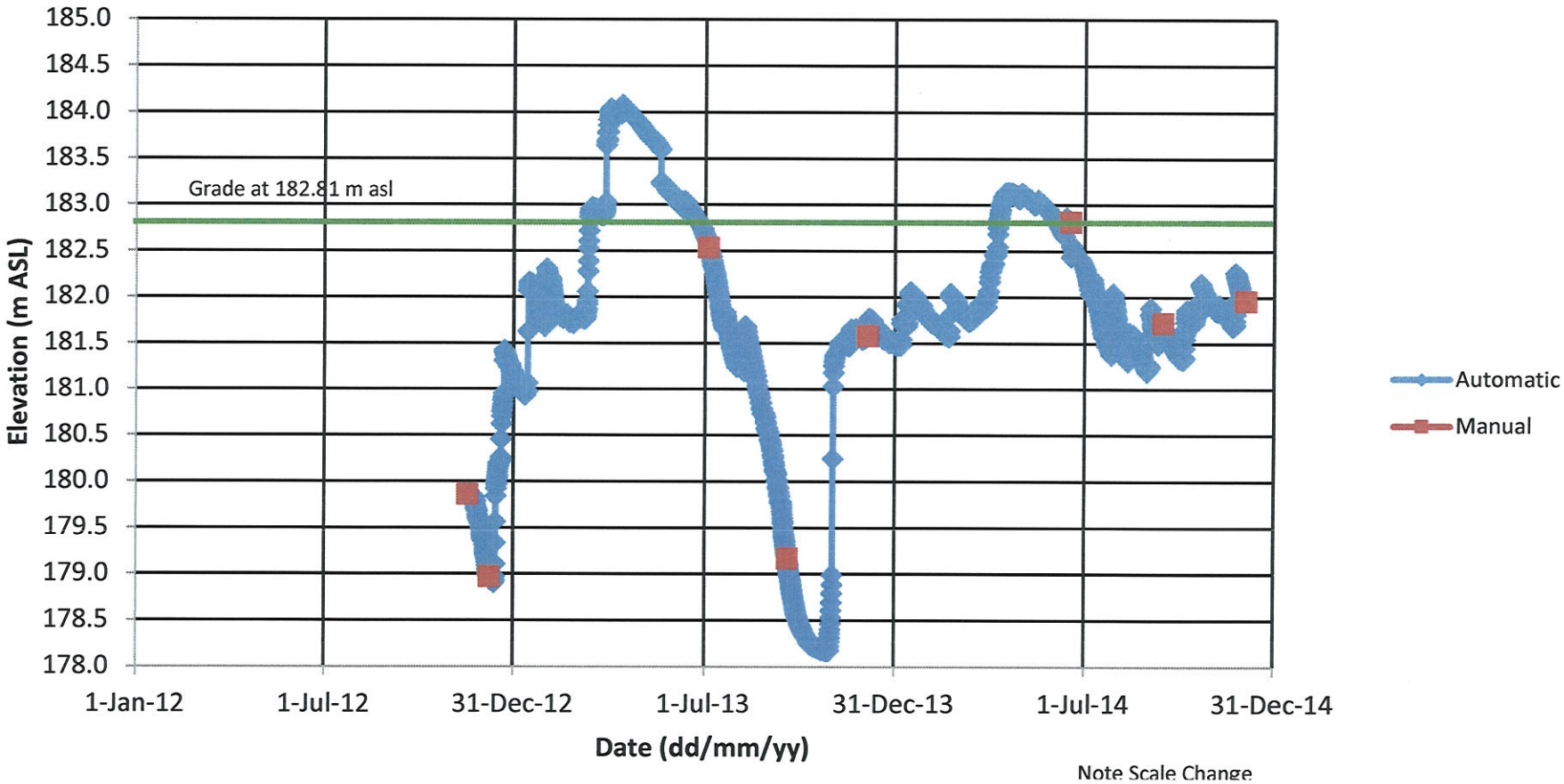


Figure A-9
BH05-20: Groundwater Temperature

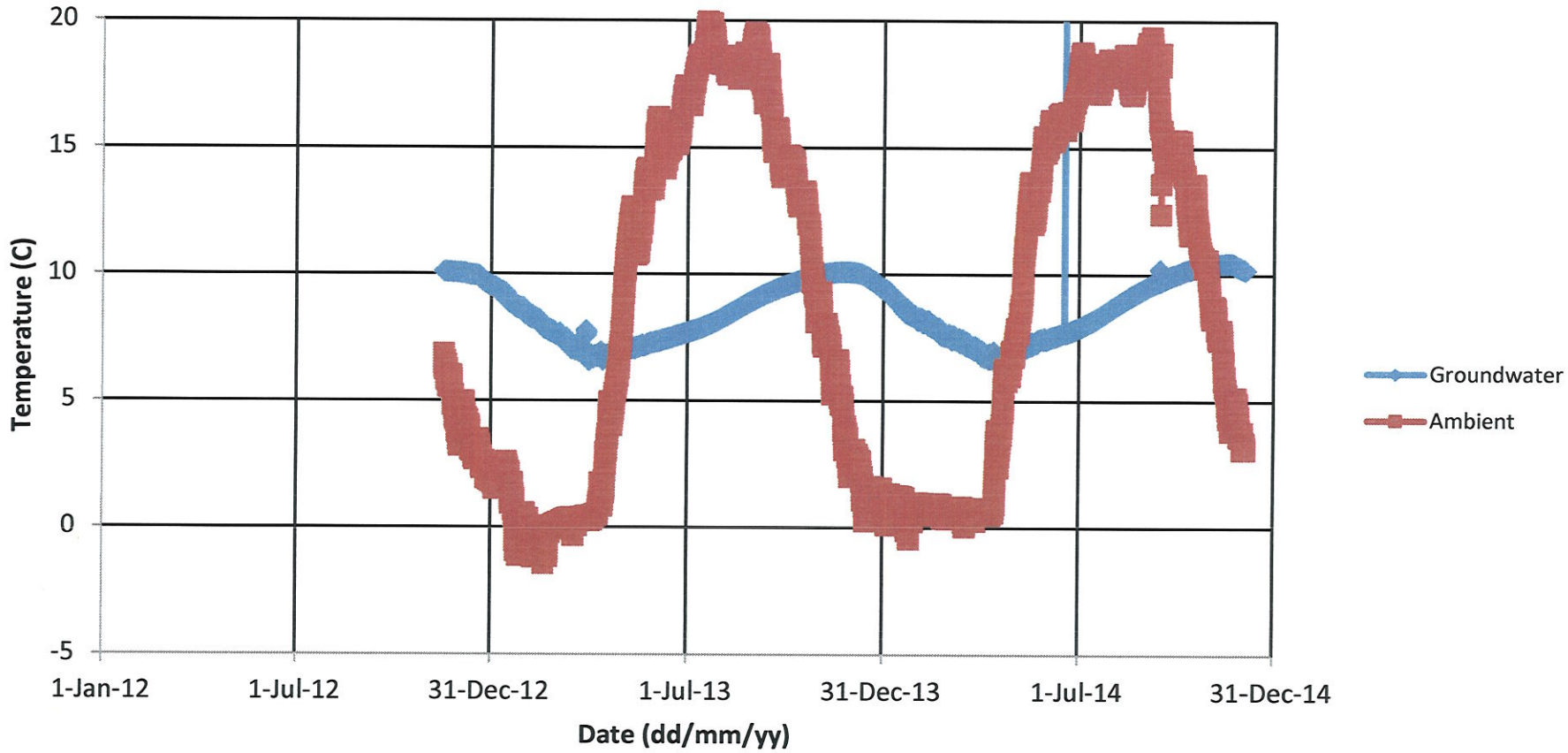


Figure A-10
BH06-1: Groundwater Elevation

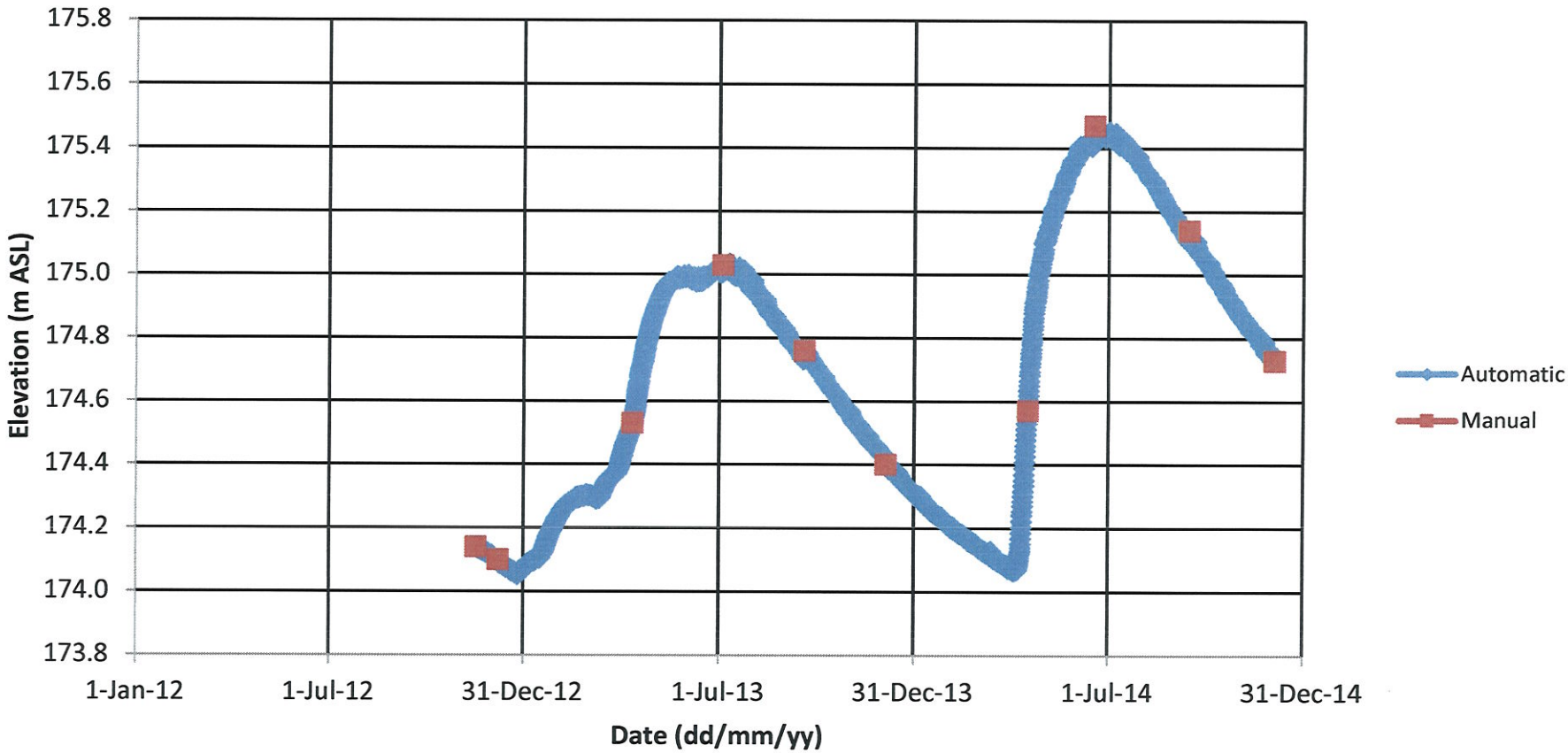


Figure A-11
BH06-1: Groundwater Temperature

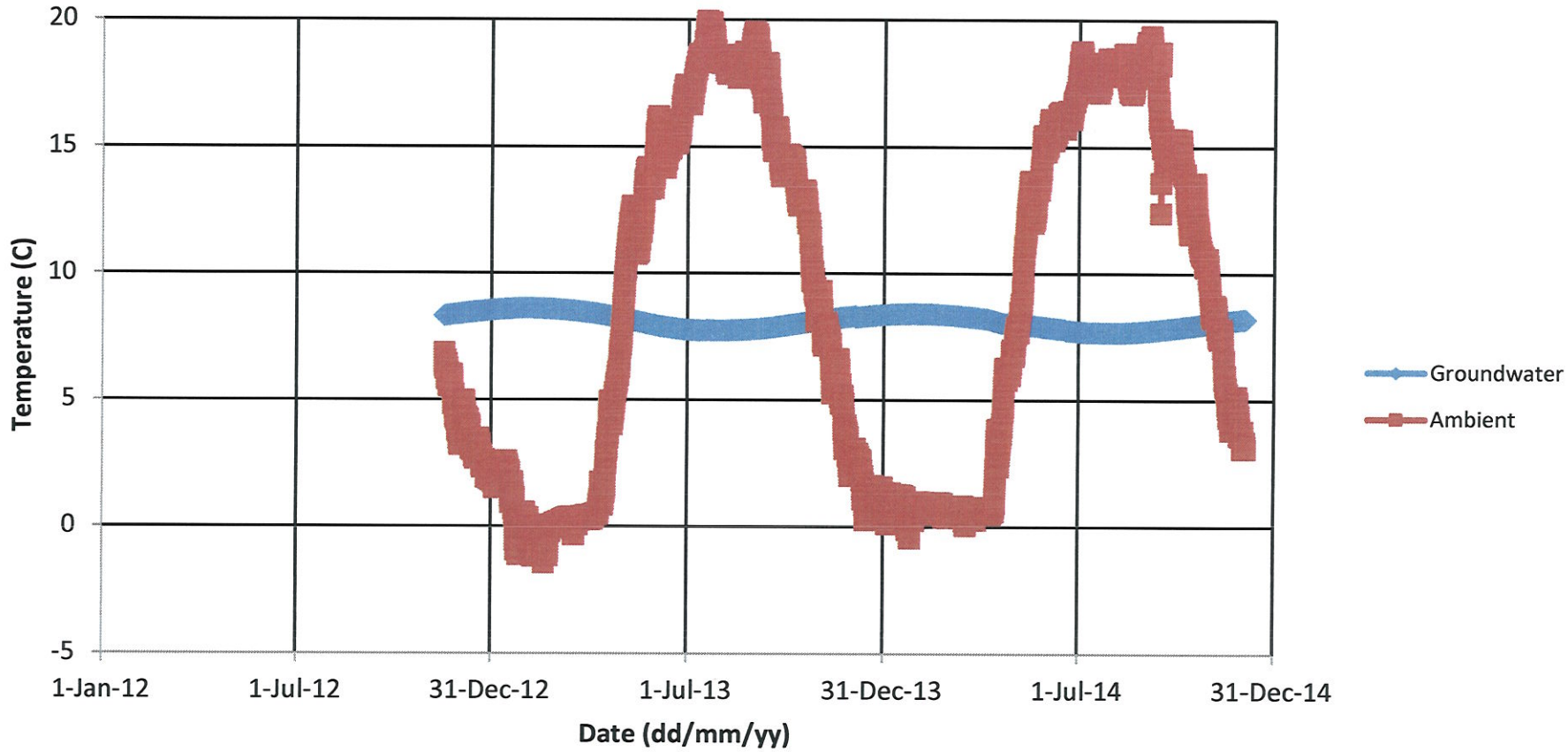


Figure A-12
BH12-1: Groundwater Elevation

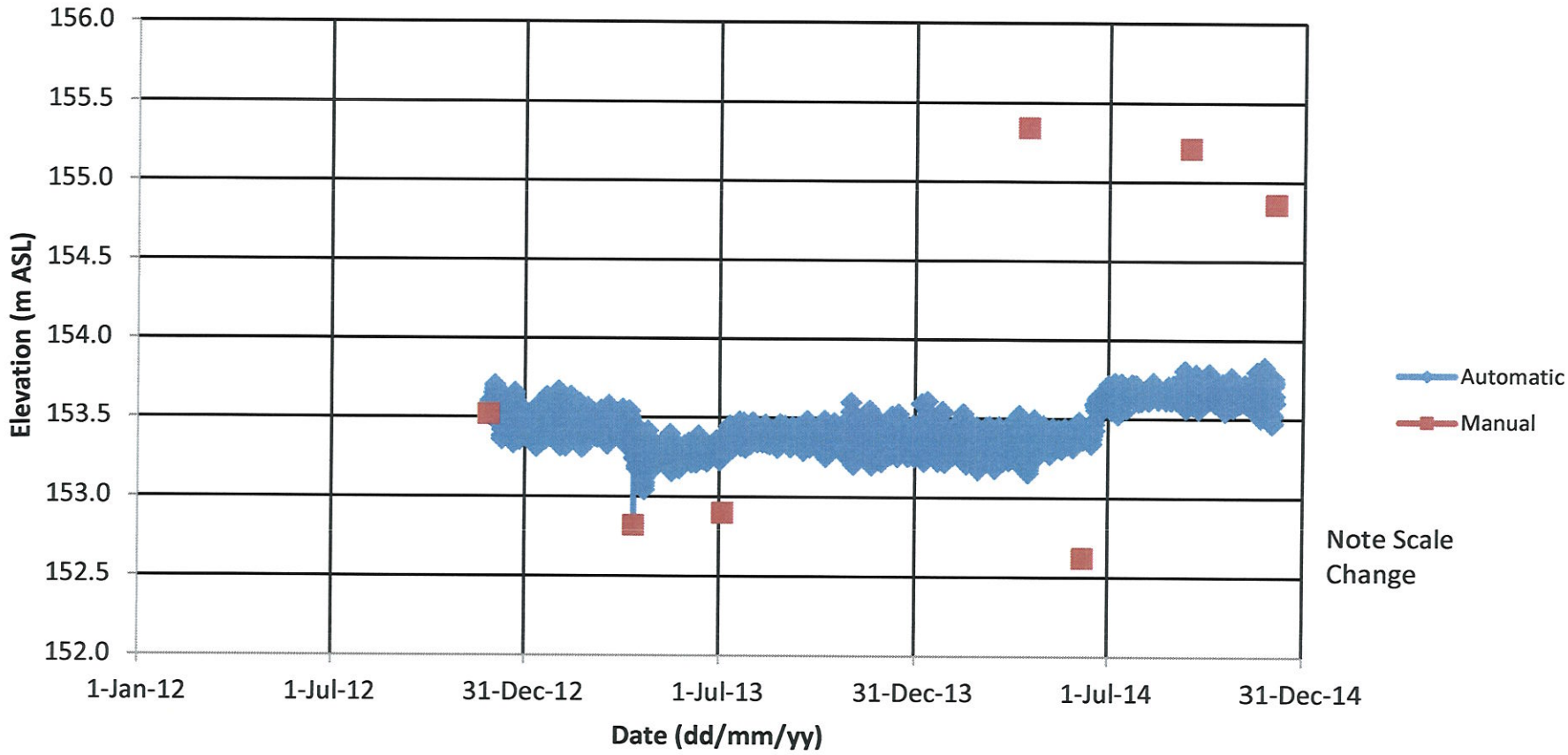


Figure A-13
BH12-1: Groundwater Temperature

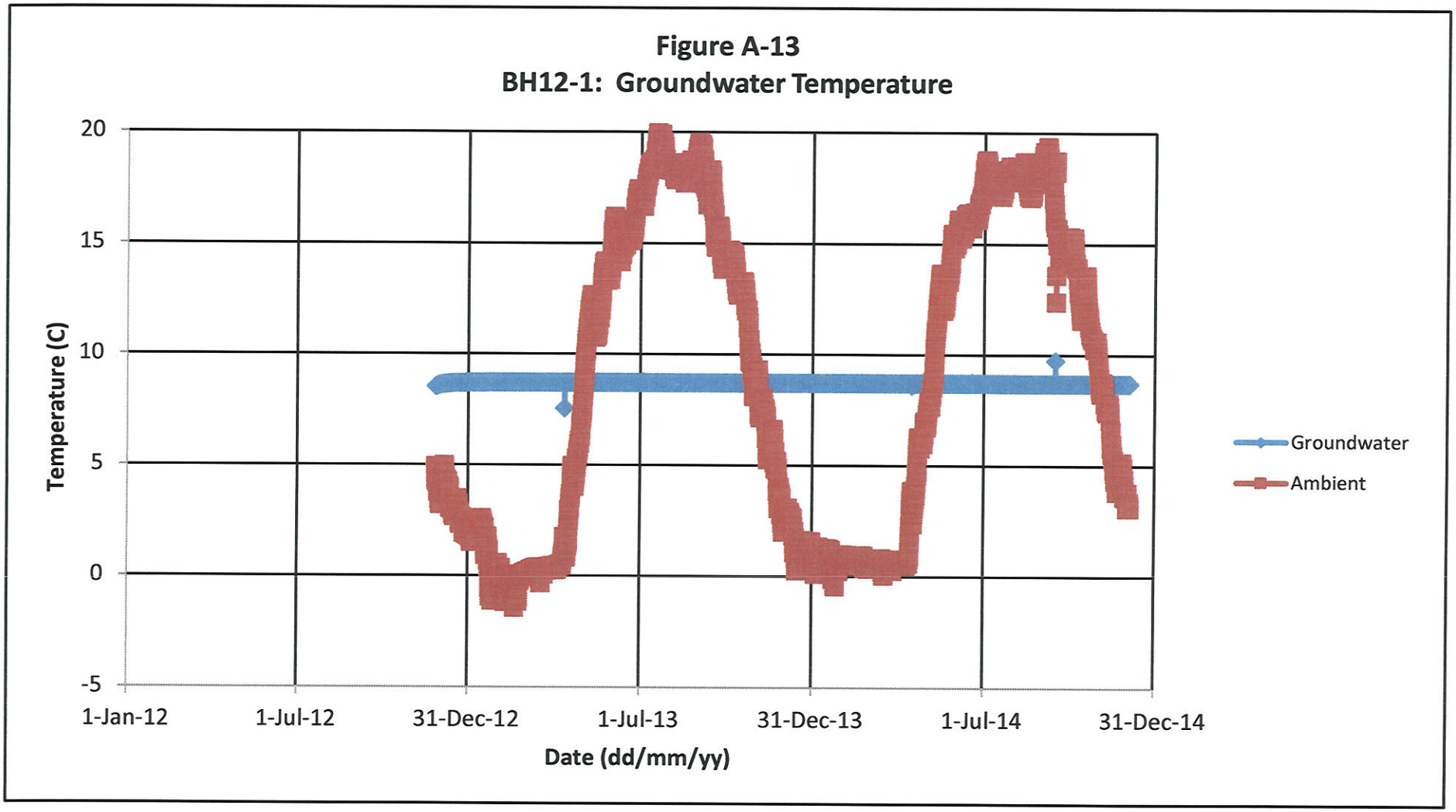


Figure A-14
BH12-2: Groundwater Elevation

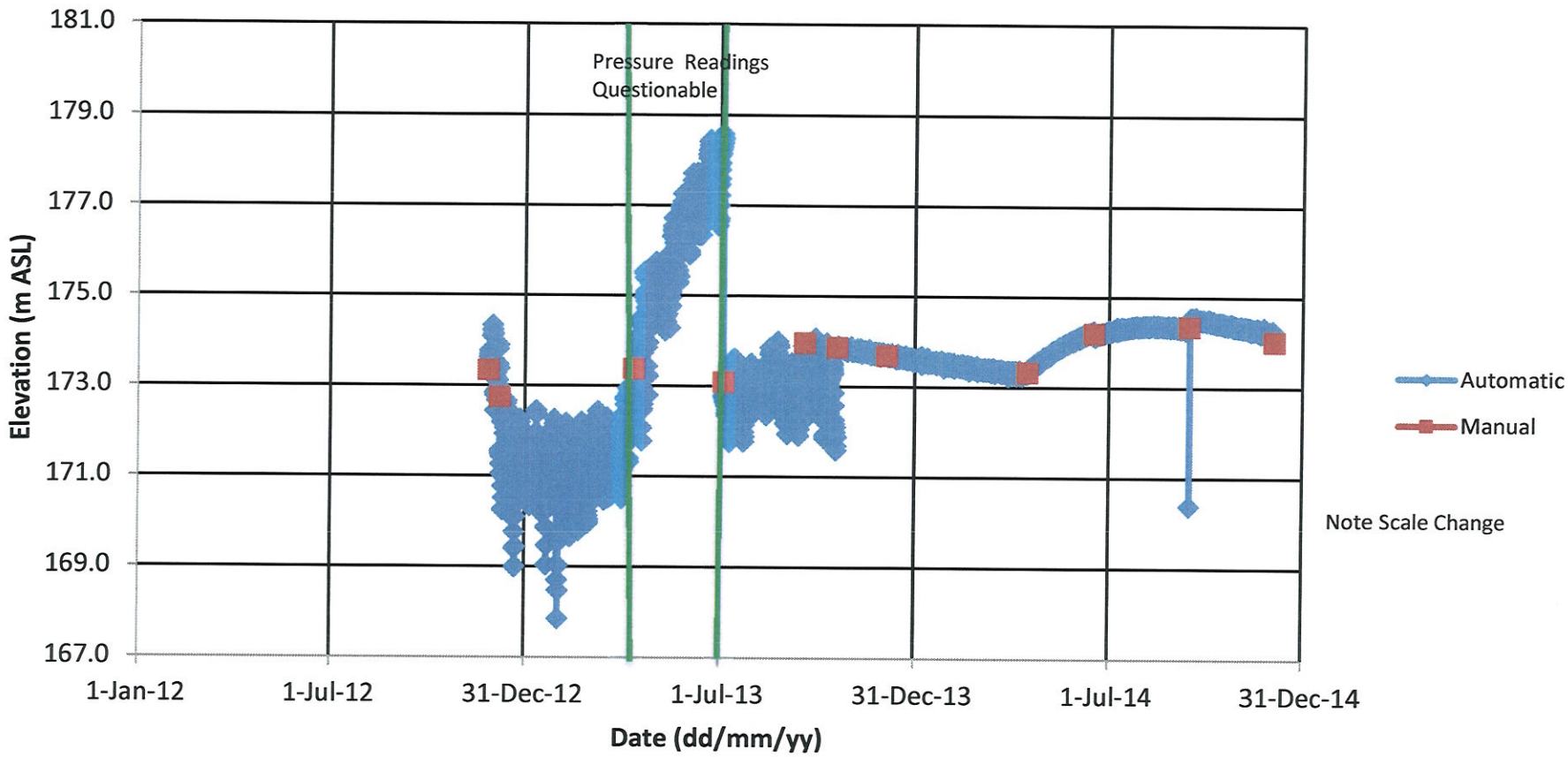


Figure A-15
BH12-2: Groundwater Temperature

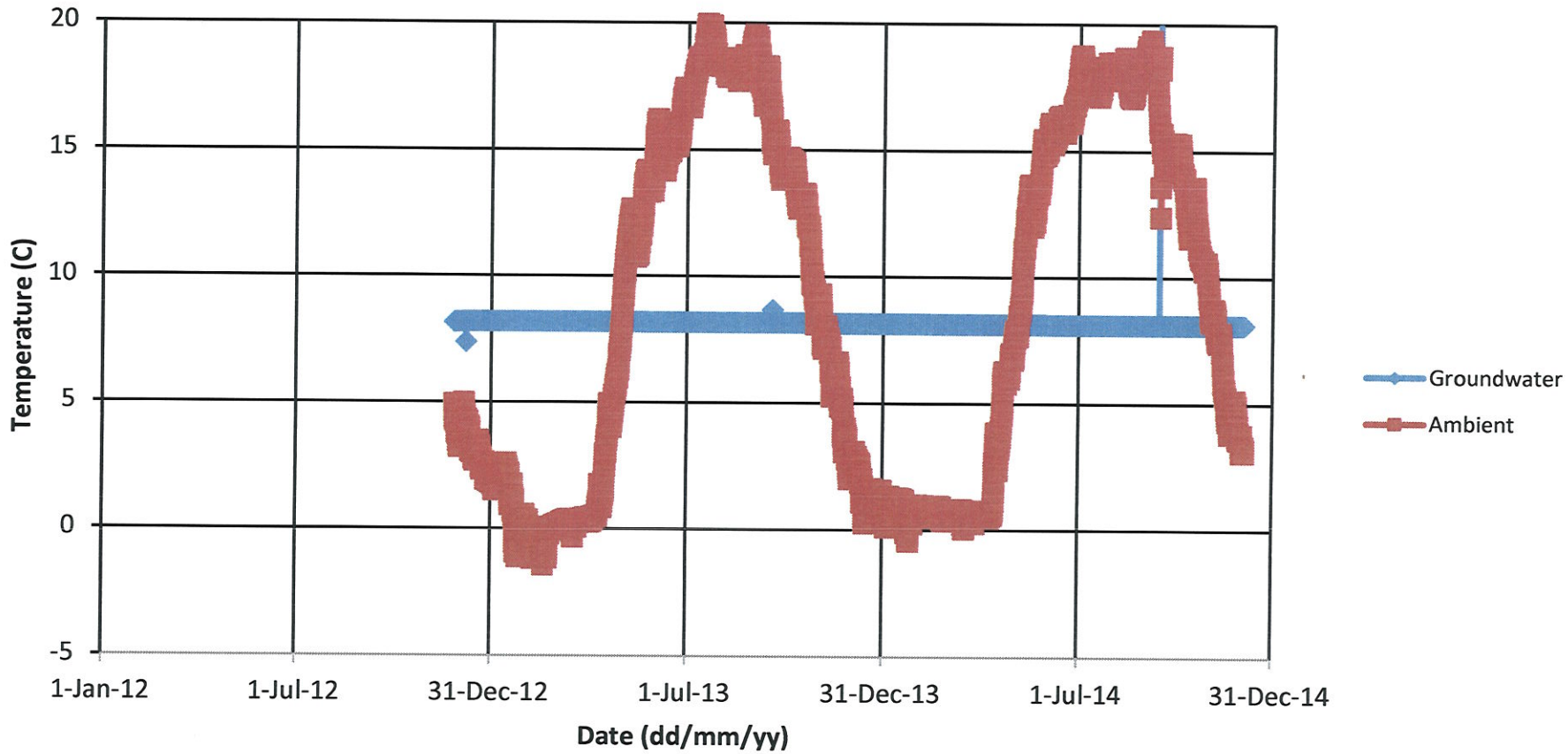


TABLE A-2
RESIDENTIAL GROUNDWATER LEVELS - WATER WELLS
CODRINGTON PIT

LOCATION																						
TYPE OF WELL	Drilled	Dug	Drilled	Dug/Drilled	Dug	Dug	Dug	Drilled	Drilled	Drilled	Drilled	Drilled	Dug	Dug	Drilled	Drilled	Dug	Dug	Dug	Drilled	Dug	Dug
DATE										No Access												
26-Jul-11	No Access				No Access			No Access	12.38		2.14		2.74	1.4	9.79							
29-Jul-11																NA						
18-Aug-11		1.81	No Access			4.73						No Access					3.23	3.14		No Access	2.14	
19-Aug-11							No Access															3.47
28-Sep-11				No Access															No Access			
10-Apr-03											NP											
11-Apr-13							NP						NA									
12-Apr-13														NP								
13-Apr-13																						0.99
15-Apr-13													NA									
04-Jul-13																					1.31	NA
05-Jul-13													2.73									
19-Sep-13													2.89									3.56
20-Sep-13																					2.39	
04-Dec-13																					1.64	
07-Dec-13													2.79									
16-Sep-14													2.8								2.11	NA

NOTES:
1) Groundwater levels in metres below top of well casing.
2) NA indicates not available owing to resident not home.
3) NP indicates no permission granted to access well and request for removal from monitoring program.

TABLE A-3
GROUNDWATER LEVELS - CODRINGTON FISH RESEARCH FACILITY
CODRINGTON PIT

	CFRC- Well2	CFRC- Well3	CFRC- Well4
Measuring Point	ND	ND	ND
Ground Elevation	ND	ND	ND
11-Apr-13	Flowing	1.4	1.94
04-Jul-13	Flowing	1.4	1.95
19-Sep-13	Flowing	1.52	2.06
04-Dec-13	Flowing	1.55	2.07
16-Apr-14	Flowing	1.26	1.82
17-Sep-14	Flowing	1.46	1.97

NOTES:
1) Groundwater elevations are presented in metres below top of casing.
2) CFRC indicates Codrington Fish Research Centre. No elevation survey of wells, thus depths below top of casing are provided.

Appendix B

Groundwater Chemical Results

- Groundwater Quality – On-site Monitoring Wells – Table B-1
- Groundwater Quality – 488 Old Wooler Road – Table B-2
- Groundwater Quality – 232 Aranda Way – Table B-3
- Groundwater Quality – 130 Jameson Road - Table B-4

TABLE B-1
GROUNDWATER QUALITY - ON-SITE MONITORING WELLS
CODRINGTON PIT

PARAMETERS	UNITS	ODWSOG	MONITORING WELLS												
			BH05-18	BH05-18	BH05-19	BH05-19	BH05-20	BH05-20	BH06-1	BH06-1	BH12-1	BH12-2	BH12-2	BH05-2	BH05-2
DATE			**15-Apr-14**	**15-Sep-14**	**15-Apr-14**	**15-Sep-14**	**17-Jun-14**	**15-Sep-14**	**15-Apr-14**	**15-Sep-14**	**15-Sep-14**	**15-Apr-14**	**15-Sep-14**	**15-Apr-14**	**15-Sep-14**
Field Parameters															
pH	pH	6.5 - 8.5	7.74	7.83	7.82	6.7	7.78*	7.5	7.71	7.63	7.832	7.77	7.48	7.65	7.35
Temperature	^{0}C	15	6	10.4	5.4	12.6		13.1	6.6	9	12.3	6.7	9.3	3.8	9.2
Conductivity	(µS/cm)		450	381	465	406	542*	494	477	414	471	445	390	422	397
Dissolved Oxygen	mg/L		10.32	9.1	11.21	10.2		7	9.92	9	7.2	10.01	8.8	10.86	9.3
Turbidity	NTU	5	**>200**	**>200**	**>200**	**>200**	**56.6**	**>200**	**>200**	**>200**	**>200**	**>200**	**>200**	**>200**	**>200**
Inorganics															
TDS	mg/L	500	280	254	274	290	336	314	306	272	294	264	256	236	250
Hardness (CaCO3)	mg/L	80 - 100	**201**	**218**	**208**	**236**	**247**	**294**	**233**	**235**	**266**	**224**	**257**	**209**	**250**
Total Ammonia-N	mg/L		0.33	0.04	0.06	0.06	0.29	<0.02	0.94	<0.02	0.1	0.27	<0.02	0.49	<0.02
Ammonia (unionized)	mg/L		<0.2	<0.02	<0.2	<0.02	<0.02	<0.02	<0.2	<0.02	<0.02	<0.2	<0.02	<0.2	<0.02
Conductivity	uS/cm		451	435	453	452	542	546	449	430	557	442	459	398	471
Dissolved Organic Carbon	mg/L	5.0	1.1	0.8	1	2	2.5	1.4	1.1	0.7	2	2.2	0.7	1.5	1
Orthophosphate (P)	mg/L		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
pH	pH	6.5 - 8.5	8.16	8.08	8.08	8.12	7.78	8.22	8.06	8.19	8.18	8.04	8.14	8.13	8.05
Sulphate (SO4)	mg/L	500	4.3	5.02	6.98	6.82	8.12	8.18	7.73	7.84	20.3	7.94	8.07	2.84	3.35
Alkalinity (Total as CaCO3)	mg/L		158	163	190	196	292	261	216	203	245	209	216	191	228
Chloride (Cl)	mg/L	250	8.1	7.81	2.93	2.53	2.84	3.14	1.2	1.37	4.34	1.89	2.27	1	1.13
Nitrite (N)	mg/L	1.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate (N)	mg/L	10.0	**10.8**	9.39	5.52	4.91	<0.05	<0.05	0.08	<0.05	1.65	0.36	0.74	0.08	0.07
Nitrate + Nitrite	mg/L	10.0	**10.8**	9.39	5.52	4.91	<0.07	<0.07	0.08	<0.07	1.65	0.36	0.74	0.08	0.07
Metals															
Aluminum (Al)	mg/L	0.1	<0.004	0.004	<0.004	<0.004	<0.004	0.013	<0.004	<0.004	0.005	<0.004	<0.004	<0.004	<0.004
Barium (Ba)	mg/L	1.0	0.051	0.056	0.067	0.066	0.017	0.019	0.029	0.029	0.07	0.186	0.087	0.022	0.032
Beryllium (Be)	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	mg/L	5.0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.019	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)	mg/L	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium (Ca)	mg/L		64.6	71.9	63.9	74.5	81.5	99.6	81.8	81.6	75.3	74	86.6	78.5	91.8
Chromium (Cr)	mg/L	0.05	<0.003	<0.003	0.011	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.013	<0.003	<0.003	<0.003
Cobalt (Co)	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	<0.001
Copper (Cu)	mg/L	1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Iron (Fe)	mg/L	0.3	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.189	<0.010	<0.010	<0.010
Lead (Pb)	mg/L	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Magnesium (Mg)	mg/L		9.66	9.36	11.8	12.1	10.5	11	7.08	7.69	18.9	9.44	9.92	3.27	4.95
Manganese (Mn)	mg/L	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	0.022	<0.002	<0.002	<0.002	**0.95**	<0.002	<0.002	<0.002
Molybdenum (Mo)	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002
Nickel (Ni)	mg/L		<0.003	<0.003	0.004	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.016	<0.003	<0.003	<0.003
Phosphorus (P)	mg/L		0.04		0.66				0.35			1.07		0.04	
Potassium (K)	mg/L		0.73	0.8	0.75	0.94	0.45	0.51	0.58	0.63	3.21	0.89	1.14	0.47	0.69
Silver (Ag)	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sodium (Na)	mg/L	200/20	2.13	2.52	1.96	1.96	4.56	5.17	1.56	1.46	11.8	1.81	1.77	0.81	0.96
Strontium (Sr)	mg/L		0.123	0.132	0.146	0.149	0.175	0.197	0.15	0.156	0.812	1.02	0.147	0.107	0.134
Vanadium (V)	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	mg/L	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.257	0.012	<0.005	<0.005	<0.005

NOTES:

1. ODWSOG indicates Ontario Drinking Water Standards, Objectives, and Guidelines (2006).
2. Bolding and shading denotes concentration exceeds ODWQO.
3. mg/L indicates milligrams per litre.
4. Blank denotes no ODWQO or parameter not tested..
5. '*' indicates value based on lab value.
6. EF indicates equipment failure.

TABLE B-2
GROUNDWATER QUALITY RESULTS -
CODRINGTON PIT

PARAMETERS MEASURED	UNITS	ODWSOG			
DATE			**26-Jul-11**	**05-Jul-13**	**16-Sep-14**
TDS	mg/L	500 (AO)	285	252	336
Hardness (CaCO3)	mg/L	80 - 100 (AO)	**270**	**249**	**304**
Total Ammonia-N	mg/L		0.32	0.21	<0.02
Conductivity	umho/cm		517	496	561
Dissolved Organic Carbon	mg/L	5 (AO)	1.8	1.6	1.8
Orthophosphate (P)	mg/L		<0.01	<0.50	<0.20
pH	pH	6.5 - 8.5 (OG)	7.87	8.49	8.11
Sulphate (SO4)	mg/L	500 (AO)	5	3.5	5.63
Alkalinity (Total as CaCO3)	mg/L	30 - 500 (OG)	262	258	280
Chloride (Cl)	mg/L	250 (AO)	5	3.22	8.17
Nitrite (N)	mg/L	1.0 (*)	<0.01	<0.25	<0.10
Nitrate (N)	mg/L	10.0 (*)	0.7	<0.25	1.6
Nitrate + Nitrite	mg/L		0.7	<0.07	1.6
Microbiological					
Total Coliforms	CFU/100mL	NOT DETECTED	**>2000**	0	ND
Fecal Streptococcus	CFU/100mL			<1	ND
Heterotrophic Plate Count	CFU/1mL			0	55
Coliform Background Count	CFU/100mL			0	ND
Escherichia coli	CFU/100mL	NOT DETECTED	**7 (1)**	0	ND
Metals					
Aluminum (Al)	µg/L	100 (OG)	15	<4	<4
Barium (Ba)	µg/L	1,000 (MAC)*	43	32	45
Beryllium (Be)	µg/L		<0.5	<1	<1
Boron (B)	µg/L	5,000 (IMAC)	17	<10	11
Cadmium (Cd)	µg/L	5 (MAC)*	<0.1	<2	<2
Calcium (Ca)	µg/L		99,000	92,400	113,000
Chromium (Cr)	µg/L	50 (MAC)*	<5	<3	<3
Cobalt (Co)	µg/L		<0.5	<1	<1
Copper (Cu)	µg/L	1,000 (AO)	<1	15	11
Iron (Fe)	µg/L	300 (AO)	<100	91	<10
Lead (Pb)	µg/L	10 (MAC)*	<0.5	<2	<2
Magnesium (Mg)	µg/L		4,700	4,330	5,350
Manganese (Mn)	µg/L	50 (MAC)*	23	**60**	2
Molybdenum (Mo)	µg/L		<0.5	<2	<2
Nickel (Ni)	µg/L		<1	<3	<3
Phosphorus (P)	µg/L		<100	<50	
Potassium (K)	µg/L		<200	260	260
Silver (Ag)	µg/L		<0.1	<2	<2
Sodium (Na)	µg/L	(**)	2,800	2,350	4,080
Strontium (Sr)	µg/L		170	176	183
Vanadium (V)	µg/L		<0.5	<2	<2
Zinc (Zn)	µg/L	5,000 (AO)	<5	7	20

NOTES:

1. ODWSOG - Ontario Drinking Water Standards, Objectives and Guidelines (2003), updated June 2006.
2. (*) denotes health related drinking water standard.
3. OG denotes the Operational Guidelines.
4. AO denotes Aesthetic Objective.
5. Bolding and shading denotes concentration exceeds ODWSOG.
6. mg/L indicates milligrams per litre. ug/L indicates micrograms per litre.
7. Blank denotes no ODWSOG has been set yet.
8. CFU/100ml denotes number of colony forming units per 100 millilitres of water.
9. "<" denotes less than detection limit (not detected).

TABLE B-3
GROUNDWATER QUALITY RESULTS -
CODRINGTON PIT

PARAMETERS MEASURED	UNITS	ODWSOG			
DATE			**18-Aug-11**	**04-Jul-13**	**16-Sep-14**
TDS	mg/L	500 (AO)	314	330	308
Hardness (CaCO3)	mg/L	80 - 100 (AO)	**280**	**294**	**285**
Total Ammonia-N	mg/L		<0.05	0.23	0.04
Conductivity	umho/cm		556	627	563
Dissolved Organic Carbon	mg/L	5 (AO)	1.1	1.7	1.1
Orthophosphate (P)	mg/L		0.01	<0.50	<0.20
pH	pH	6.5 - 8.5 (OG)	7.87	8.27	8.13
Sulphate (SO4)	mg/L	500 (AO)	8	8.7	7.6
Alkalinity (Total as CaCO3)	mg/L	30 - 500 (OG)	264	292	270
Chloride (Cl)	mg/L	250 (AO)	16	15.2	18
Nitrite (N)	mg/L	1.0 (*)	<0.01	<0.25	<0.10
Nitrate (N)	mg/L	10.0 (*)	0.1	1.18	<0.10
Nitrate + Nitrite	mg/L		0.1	1.18	<0.07
Microbiological					
Total Coliforms	CFU/100mL	NOT DETECTED	**30**	**128**	ND
Fecal Streptococcus	CFU/100mL			<1	ND
Heterotrophic Plate Count	CFU/1mL			90	710
Coliform Background Count	CFU/100mL			34	ND
Escherichia coli	CFU/100mL	NOT DETECTED	0	0	ND
Metals					
Aluminum (Al)	µg/L	100 (OG)	6	<4	<4
Barium (Ba)	µg/L	1,000 (MAC)*	43	51	41
Beryllium (Be)	µg/L		<0.5	<1	<1
Boron (B)	µg/L	5,000 (IMAC)	11	15	16
Cadmium (Cd)	µg/L	5 (MAC)*	<0.1	<2	<2
Calcium (Ca)	µg/L		100,000	104,000	101,000
Chromium (Cr)	µg/L	50 (MAC)*	<5	<1	<3
Cobalt (Co)	µg/L		<0.5	<1	<1
Copper (Cu)	µg/L	1,000 (AO)	7	48	8
Iron (Fe)	µg/L	300 (AO)	<100	<10	<10
Lead (Pb)	µg/L	10 (MAC)*	1.2	<2	<2
Magnesium (Mg)	µg/L		7,200	8,300	8,060
Manganese (Mn)	µg/L	50 (MAC)*	7	<2	18
Molybdenum (Mo)	µg/L		<0.5	<2	<2
Nickel (Ni)	µg/L		<1	<3	<3
Phosphorus (P)	µg/L		<100	<50	
Potassium (K)	µg/L		2,600	2,500	2,460
Silver (Ag)	µg/L		<0.1	<2	<2
Sodium (Na)	µg/L	(**)	10,000	8,590	10,700
Strontium (Sr)	µg/L		230	305	271
Vanadium (V)	µg/L		<0.5	<2	<2
Zinc (Zn)	µg/L	5,000 (AO)	280	449	379

NOTES:

1. ODWSOG - Ontario Drinking Water Standards, Objectives and Guidelines (2003), updated June 2006.
2. (*) denotes health related drinking water standard.
3. OG denotes the Operational Guidelines.
4. AO denotes Aesthetic Objective.
5. Bolding and shading denotes concentration exceeds ODWSOG.
6. mg/L indicates milligrams per litre. ug/L indicates micrograms per litre.
7. Blank denotes no ODWSOG has been set yet.
8. CFU/100ml denotes number of colony forming units per 100 millilitres of water.
9. "<" denotes less than detection limit (not detected).

TABLE B-4
GROUNDWATER QUALITY RESULTS -
CODRINGTON PIT

PARAMETERS MEASURED	UNITS	ODWSOG		
			18-Aug-11	11-Apr-13
TDS	mg/L	500 (AO)	357	300
Hardness (CaCO3)	mg/L	80 - 100 (AO)	**300**	**272**
Total Ammonia-N	mg/L		0.06	0.09
Conductivity	umho/cm		628	566
Dissolved Organic Carbon	mg/L	5 (AO)	0.9	1.2
Orthophosphate (P)	mg/L		<0.01	<0.10
pH	pH	6.5 - 8.5 (OG)	7.78	8.24
Dissolved Sulphate (SO4)	mg/L	500 (AO)	12	6.57
Alkalinity (Total as CaCO3)	mg/L	30 - 500 (OG)	299	269
Dissolved Chloride (Cl)	mg/L	250 (AO)	16	8.94
Nitrite (N)	mg/L	1.0 (*)	<0.01	<0.05
Nitrate (N)	mg/L	10.0 (*)	0.4	0.14
Nitrate + Nitrite	mg/L	10.0 (*)	0.4	0.14
Microbiological				
Background	CFU/100mL			ND
Heterotrophic Plate Count	CFU/1mL			340
Total Coliforms	CFU/100mL	NOT DETECTED	**100 (1)**	**27**
Fecal Streptococcus	CFU/100mL			3
Escherichia coli	CFU/100mL	NOT DETECTED	0 (1)	ND
Metals				
Aluminum (Al)	mg/L	0.100 (OG)	<0.005	0.005
Barium (Ba)	mg/L	1.0 (MAC)*	0.058	0.044
Beryllium (Be)	mg/L		<0.0005	<0.001
Boron (B)	mg/L	5.0 (IMAC)	0.028	0.035
Cadmium (Cd)	mg/L	0.005 (MAC)*	<0.0001	<0.002
Calcium (Ca)	mg/L		110	97.7
Chromium (Cr)	mg/L	0.050 (MAC)*	<0.005	<0.003
Cobalt (Co)	mg/L		<0.0005	<0.001
Copper (Cu)	mg/L	1.0 (AO)	0.027	0.56
Iron (Fe)	mg/L	0.300 (AO)	<0.100	0.051
Lead (Pb)	mg/L	0.010 (MAC)*	0.0007	<0.002
Magnesium (Mg)	mg/L		9.4	6.91
Manganese (Mn)	mg/L	0.050 (MAC)*	<0.002	<0.002
Molybdenum (Mo)	mg/L		<0.0005	<0.002
Nickel (Ni)	mg/L		<0.001	<0.003
Phosphorus (P)	mg/L		<0.100	<0.05
Potassium (K)	mg/L		1.3	0.89
Silver (Ag)	mg/L		<0.0001	<0.002
Sodium (Na)	mg/L		17	9.71
Strontium (Sr)	mg/L		0.27	0.228
Vanadium (V)	mg/L		0.0011	<0.002
Zinc (Zn)	mg/L	5.0 (AO)	0.01	0.018

NOTES:

1. ODWSOG - Ontario Drinking Water Standards, Objectives and Guidelines (2003), updated June 2006.
2. (*) denotes health related drinking water standard.
3. OG denotes the Operational Guidelines.
4. AO denotes Aesthetic Objective.
5. Bolding and shading denotes concentration exceeds ODWSOG.
6. mg/L denotes milligrams per litre.
7. Blank denotes no ODWSOG has been set yet.
8. CFU/100ml denotes number of colony forming units per 100 millilitres of water.
9. "<" denotes less than detection limit (not detected).

Appendix C

Surface Water Chemical Results

- Surface Water Quality – Local Stations – Table C-1
- Surface Water Quality – Codrington Fish Research Centre – Table C-2
- Surface Water Flow Rates – April 2013 – Table C-3
- Spring Assessment – April 2013 – Figure C-1

TABLE C-1
SURFACE WATER QUALITY - LOCAL STATIONS
CODRINGTON PIT

PARAMETERS	UNITS	PWQO	SAMPLING STATIONS												
			Pond North of Pit	SWB	SWB	SWB	SWB	SWB	SWB	SWC	SWC	SWC	SWC	SWC	SWC
DATE			**19-Aug-11**	**11-Apr-13**	**4-Jul-13**	**19-Sep-13**	**4-Dec-13**	**15-Apr-14**	**15-Sep-14**	**11-Apr-13**	**4-Jul-13**	**19-Sep-13**	**4-Dec-13**	**15-Apr-14**	**15-Sep-14**
Field Parameters															
pH	pH	6.5 - 8.5	8.22	7.75	EF	7.91	8.54	8.23	7.79	8.33	EF	8.02	8.42	7.79	8.02
Temperature	t^0C		21.6	5.6	11	11	6.5	5.7	10	3.6	22.6	17.2	3.1	6	14.1
Conductivity	(µS/cm)		2287	407	415	346	437	429	376	370	355	316	452	420	329
Dissolved Oxygen	mg/L			10	12.31	9.8*	11.4	12.2	9.0	9.8	9.49	9.5*	11.6	9.9	8.9
Turbidity	NTU			4.09	<1	1.9*	4.1	7.3	<0.5	17.9	1.4	8.8*	6.4	16.6	10.6
Flow Rate	L/s			0.35	1.67	0.87	1.13	1.3	1.0	50	2.8	<1	10.5	51.9	5.6
Inorganics															
TDS	mg/L		165	238	220	232	232	266	244	234	198	220	246	280	230
Hardness (CaCO3)	mg/L		140	233	218	232	232	218	231	190	178	172	242	197	194
Total Ammonia-N	mg/L		<0.05	0.063	0.143	<0.02	<0.02	0.13	<0.02	0.047	0.275	<0.02	0.03	0.82	0.05
Ammonia (unionized)	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0;02	<0.02	<0.02	<0.02	<0.02
Conductivity	umho/cm		321	454	443	439	440	447	456	412	372	335	458	452	368
Dissolved Organic Carbon	mg/L		4.2	0.9	1	1.2	1.4	2.5	0.9	6.7	4.2	4.2	2.8	11.4	4.7
Orthophosphate (P)	mg/L		<0.01	<0.100	<0.100	<0.10	<0.10	<0.10	<0.10	<0.100	<0.100	0.22	<0.10	0.51	<0.10
pH	pH	6.5 - 8.5	8.16	8.04	8.41	7.78	8.28	8.3	8.16	7.87	8.34	7.78	8.28	8.17	8.24
Sulphate (SO4)	mg/L		5	6.24	5.2	4.73	5.07	5.36	4.82	7.15	4.35	5.94	7.84	6.97	5.42
Alkalinity (Total as CaCO3)	mg/L		169	222	230	250	239	219	229	176	189	185	231	197	174
Chloride (Cl)	mg/L		<1	1.02	0.967	0.99	1.02	1.06	1.1	8.36	1.84	1.52	1.88	9.95	1.8
Nitrite (N)	mg/L		<0.01	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.050	<0.050	<0.05	<0.05	0.08	<0.05
Nitrate (N)	mg/L		<0.1	0.104	0.082	0.08	0.08	0.16	<0.05	2.08	<0.050	0.16	0.09	0.58	<0.05
Nitrate + Nitrite	mg/L		<0.1	0.104	0.082	0.08	0.08	0.16	<0.07	2.08	<0.070	0.16	0.09	0.66	<0.07
Metals															
Aluminum (Al)	µg/L	75	**110**	4.2	14	10	<4	22	<4	10.4	15.5	13	<4	13	<4
Barium (Ba)	µg/L		33	69.1	57.1	62	64	51	60	43.9	38.7	62	53	32	56
Beryllium (Be)	µg/L	1100	<0.5	<2.0	<2.0	<1	<1	<1	<1	<2.0	<2.0	<1	<1	<1	<1
Boron (B)	µg/L	200	<10	<10	<10	<10	13	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium (Cd)	µg/L	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	µg/L		49000	81700	76600	81800	81100	77300	81200	64400	58400	56300	82000	67500	63800
Chromium (Cr)	µg/L	8.9	<5	<3.0	<3.0	<3	<3	<3	<3	<3.0	<3.0	<3	<3	3	<3
Cobalt (Co)	µg/L	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper (Cu)	µg/L	5	<1	<2.0	<2.0	<2	<2	<2	<2	<2.0	<2.0	<2	<2	<2	<2
Iron (Fe)	µg/L	300	160	<10	28	<10	230	<10	<10	240	**372**	**630**	140	200	250
Lead (Pb)	µg/L	25.0	<0.5	<1.0	<1.0	<1	1	<1	<1	<1.0	<1.0	<1	<1	<1	<1
Magnesium (Mg)	µg/L		4700	6960	6430	6790	1050	6170	6750	6990	7770	7530	9070	6980	8470
Manganese (Mn)	µg/L		23	3.9	13.7	15	40	6	12	20	65.7	98	46	39	44
Molybdenum (Mo)	µg/L	40	0.5	<2.0	<2.0	<2	<2	<2	<2	<2.0	<2.0	<2	<2	<2	<2
Nickel (Ni)	µg/L	25	<1	<3.0	<3.0	<3	<3	<3	<3	<3.0	<3.0	<3	<3	<3	<3
Phosphorus (P)	µg/L	30	<100	**36**	**48**	<20	**80**		**60**	**267**	**70**	**80**	**40**		**80**
Potassium (K)	µg/L		950	1130	1030	1110	1200	1240	1110	6190	<500	960	910	6190	770
Silver (Ag)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (Na)	µg/L		1100	1130	1070	1210	1150	1010	1170	3900	1930	1970	1980	4460	1930
Strontium (Sr)	µg/L		92	132	115	117	127	125	133	120	124	127	130	131	134
Vanadium (V)	µg/L	6	1.7	<2.0	<2.0	<2	<2	<2	<2	<2.0	<2.0	<2	<2	<2	<2
Zinc (Zn)	µg/L	20	<5	<5.0	7	6	8	<5	6	6.7	<5.0	<5	<5	5	<5

NOTES:

1. PWQO indicates Provincial Water Quality Objectives (1994 plus updates).
2. Bolding and shading denotes concentration exceeds PWQO.
3. mg/L indicates milligrams per litre; µg/L denotes microgram per litre.
4. Blank denotes no PWQO or parameter not tested..
5. EF indicates equipment failure.

Figure C-1
SURFACE WATER FLOW RATES

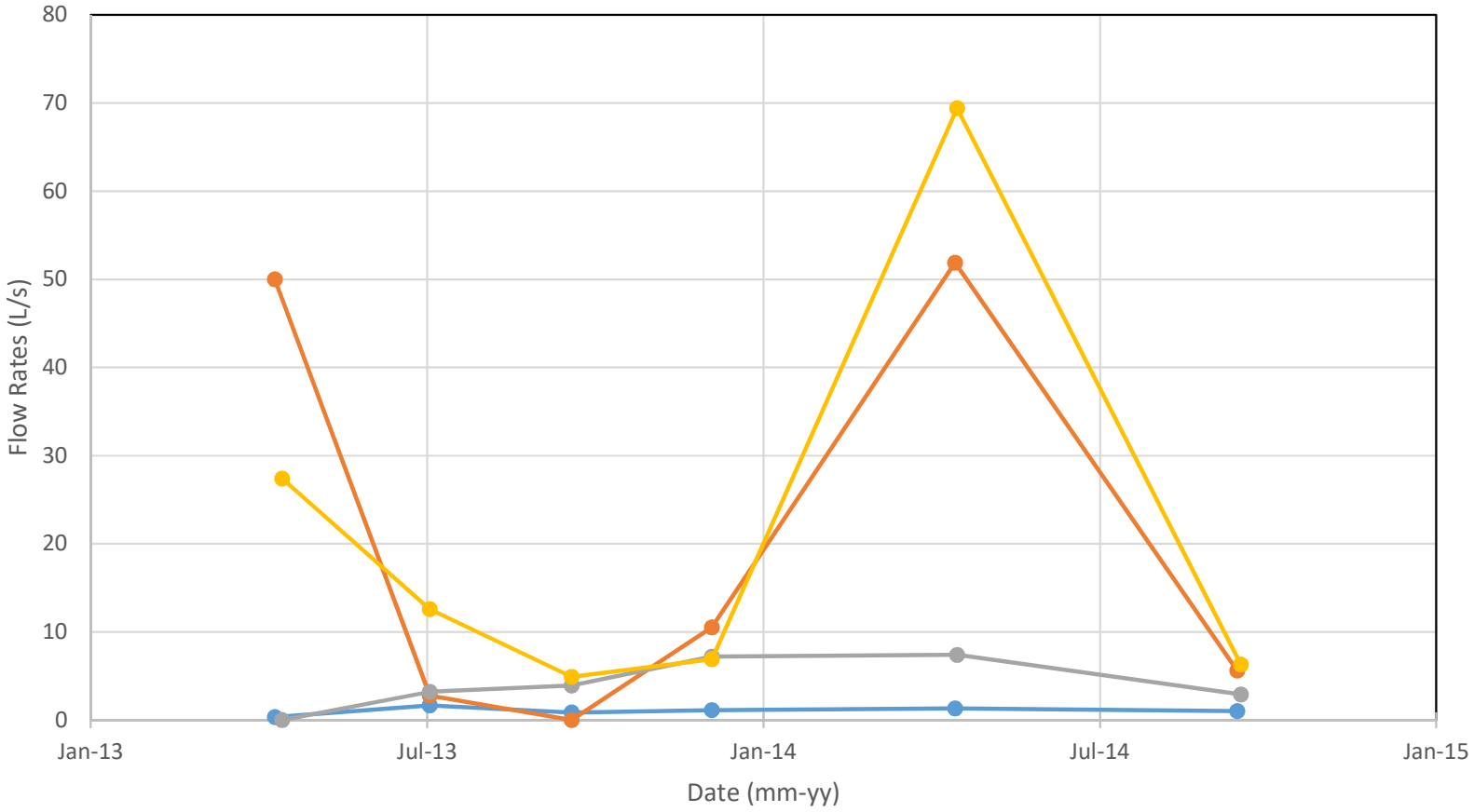


TABLE C-2
SURFACE WATER QUALITY - CODRINGTON FISH RESEARCH CENTRE
CODRINGTON PIT

PARAMETERS	UNITS	PWQO	SAMPLING STATIONS												
			Fish Hatchery Head Pond	FH-SW1	FH-SW1	FH-SW1	FH-SW1	FH-SW1	FH-SW1	FH-SW2	FH-SW2	FH-SW2	FH-SW2	FH-SW2	FH-SW2
DATE			**28-Sep-11**	**15-Apr-13**	**4-Jul-13**	**19-Sep-13**	**4-Dec-13**	**16-Apr-14**	**17-Sep-14**	**15-Apr-13**	**4-Jul-13**	**19-Sep-13**	**4-Dec-13**	**16-Apr-14**	**17-Sep-14**
Field Parameters															
pH	pH	6.5 - 8.5	7.92	7.54	EF	6.9	7.55	7.78	7.54	7.89	EF	8.02	8.06	8.2	8.11
Temperature	t^0C		11.1	8.5	9.6	9.7	7.9	8.3	9	6	12.4	10	4	3.7	8.4
Conductivity	(µS/cm)		507	475	576	483	613	600	531	411	462	383	525	373	417
Dissolved Oxygen	mg/L			6.3	5.88	9.7*	4.7	4.69	4.72	10.2	12.58	9.9*	10.5	12.55	11.85
Turbidity	NTU			1	<1	<0.5*	0.31	4.8	4.5	2.6	<1	<0.5*	0.86	3.8	3
Flow Rate	L/s			No Flow	3.2	3.9	7.2	7.4	2.9	27.4	12.6	4.9	6.9	69.4	6.3
Inorganics															
TDS	mg/L		302		332	350	316				242	280	266		
Hardness (CaCO3)	mg/L		260		273	318	298				247	261	259		
Total Ammonia-N	mg/L		<0.05		<0.020	<0.02	<0.02				0.102	<0.02	<0.02		
Ammonia (unionized)	mg/L	0.02	<0.02		<0.02	<0.02	<0.02				<0.02	<0.02	<0.02		
Conductivity	umho/cm		524		612	621	625				491	490	499		
Dissolved Organic Carbon	mg/L		1		1	0.9	<0.5				1.2	1.4	1.3		
Orthophosphate (P)	mg/L		<0.01		<0.100	<0.20	<0.20				<0.100	<0.10	<0.20		
pH	pH	6.5 - 8.5	8.15		8.41	7.76	8.22				8.53	7.98	8.31		
Sulphate (SO4)	mg/L		17		20.8	20.0	20.6				13.8	14.0	13.5		
Alkalinity (Total as CaCO3)	mg/L		241		249	271	253				244	261	242		
Chloride (Cl)	mg/L		12		30	27.9	27.8				3.3	3.63	3.42		
Nitrite (N)	mg/L		<0.01		<0.050	<0.10	<0.10				<0.050	<0.05	<0.10		
Nitrate (N)	mg/L		2.6		1.5	1.54	1.36				0.964	1.08	0.84		
Nitrate + Nitrite	mg/L		2.6		1.5	1.54	1.36				0.964	1.08	0.84		
Metals															
Aluminum (Al)	µg/L	75	5		11.6	9	<4				13.2	10	<4		
Barium (Ba)	µg/L		110		134	142	135				79.6	87	76		
Beryllium (Be)	µg/L	1100	<0.5		<2.0	<1	<1				<2.0	<1	<1		
Boron (B)	µg/L	200	11		14	<10	10				<10	<10	<10		
Cadmium (Cd)	µg/L	0.5	<0.1		<0.1	<0.1	<0.1				<0.1	<0.1	<0.1		
Calcium (Ca)	µg/L		81000		83100	98200	91300				79300	84100	83800		
Chromium (Cr)	µg/L	8.9	<5		<3.0	<3	<3				<3.0	<3	<3		
Cobalt (Co)	µg/L	0.9	<0.5		<0.5	<0.5	<0.5				<0.5	<0.5	<0.5		
Copper (Cu)	µg/L	5	<1		<2.0	<2	<2				<2.0	<2	<2		
Iron (Fe)	µg/L	300	<100		<10	<10	<10				<10	<10	<10		
Lead (Pb)	µg/L	25.0	<0.5		<1.0	<1	<1				<1.0	<1	<1		
Magnesium (Mg)	µg/L		13000		15900	17600	17000				11800	12400	12200		
Manganese (Mn)	µg/L		9		<2.0	3	<2				11.1	3.0	10		
Molybdenum (Mo)	µg/L	40	<0.5		<2.0	<2	<2				<2.0	<2	<2		
Nickel (Ni)	µg/L	25	<1		<3.0	<3	<3				<3.0	<3	<3		
Phosphorus (P)	µg/L	30	<100		<20	<20	20				<20	<20	<20		
Potassium (K)	µg/L		1300		1530	1590	1620				1110	1130	1140		
Silver (Ag)	µg/L	0.1	<0.1		<0.1	<0.1	<0.1				<0.1	<0.1	<0.1		
Sodium (Na)	µg/L		5700		10500	11900	11100				2390	2480	2500		
Strontium (Sr)	µg/L		190		293	316	301				168	167	167		
Vanadium (V)	µg/L	6	<0.5		<2.0	<2	<2				<2.0	<2	<2		
Zinc (Zn)	µg/L	20	<5		<5.0	**57**	<5				<5.0	<5	<5		

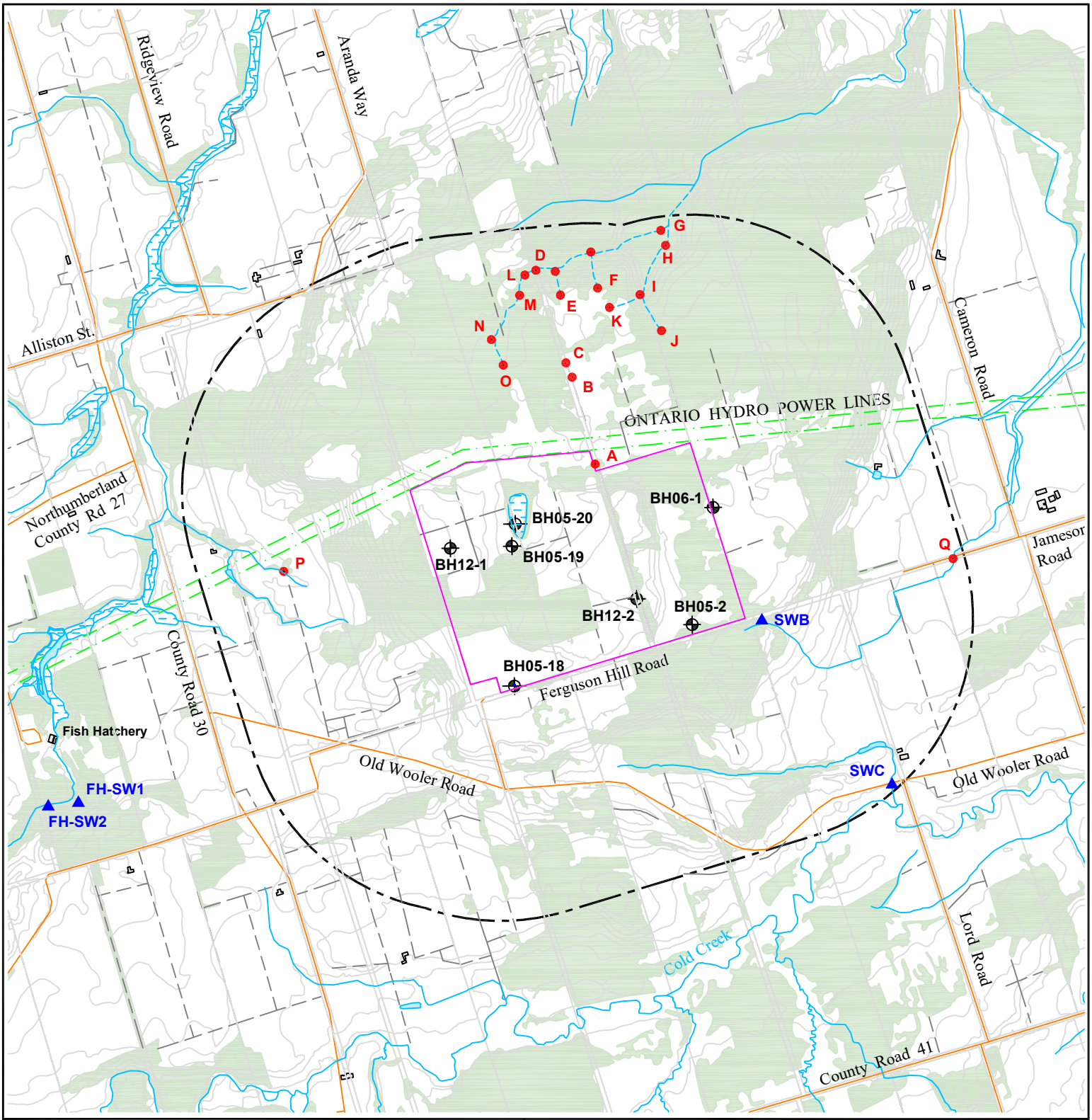
NOTES:

1. PWQO indicates Provincial Water Quality Objectives (1994 plus updates).
2. Bolding and shading denotes concentration exceeds PWQO.
3. mg/L indicates milligrams per litre; µg/L denotes microgram per litre.
4. Blank denotes no PWQO or parameter not tested..
5. EF indicates equipment failure.

TABLE C-3
SURFACE WATER FLOW RATES - APRIL 2013
CODRINGTON PIT

STATION	DATE	WIDTH (m)			DEPTH LOCATIONS (m)			DEPTH (mm)			WATERCOURSE CHARACTERISTICS	CROSS-SECTIONAL AREA (m^2)	FLOW LENGTH (m)	TIME TRIAL (s)					AVERAGE VELOCITY (m/s)	FLOW RATE (L/s)
		a	b	c	a	b	c	d1	d2	d3				t1	t2	t3	t4	t5		
SWB	11-Apr-13	0.2032	0.127	0.1016				6.35	9.53	31.75	Rectangular	0.0019	0.8128	4	5	4	4	5	0.1847	0.35
SWC	13-Apr-13	1.0287			0.254	0.508	0.762	184.15	190.5	215.9	Rectangular	0.2011	1.4732	5	7	6.5	5.5	5.5	0.2497	50.2
Location D	13-Apr-13	1.651			0.254	0.762	1.27	254	266.7	254	Rectangular	0.4323	2.032	3	3.5	3.5	3	3.5	0.6158	256.9
			1.5494					228.6	177.8	254	Rectangular	0.3935								
				1.524				203.2	266.7	279.4	Rectangular	0.4258								
Location E	13-Apr-13	0.2032			0.0254	0.1016	0.1778	19.05	63.5	50.8	Rectangular	0.0115	0.9144	4	3	3	3	3	0.2858	2.5
			0.2413					31.75	31.75	12.7	Rectangular	0.0065								
				0.2794				31.75	38.1	12.7	Rectangular	0.0079								
Location F	13-Apr-13																			<1
Location H	13-Apr-13	0.762			0.254	0.508	0.762	203.2	266.7	25.4	Rectangular	0.1871	1.8288	4.5	3.5	3.5	3	3.5	0.5080	95.6
			1.1176					88.9	241.3	241.3	Rectangular	0.2310								
				1.0668				88.9	152.4	152.4	Rectangular	0.1465								
Location M	13-Apr-13	1.524			0.254	0.762	1.27	76.2	127	114.3	Rectangular	0.1774	1.3462	3.5	2	2.5	3	2	0.5178	111.5
			1.2954					152.4	190.5	139.7	Rectangular	0.2358								
				1.4732				114.3	177.8	114.3	Rectangular	0.2329								
Location P	13-Apr-13	0.4572			0.1524	0.3048		38.1	50.8		Rectangular	0.0203	0.9144	1.5	1.5	1	1.5	1.5	0.6531	22.8
			0.381					114.3	101.6		Rectangular	0.0416								
				0.3048	0.1016	0.2032		152.4	127		Rectangular	0.0426								
Location Q	13-Apr-13	0.8128	0.8382	0.8636				330.2	330.2	330.2	Rectangular	0.2768	0.9144	4	4	4	5	4	0.2177	60.3
Location R	13-Apr-13	0.3556	0.4572	0.4572				304.8	304.8	304.8	Rectangular	0.1290	1.143	1.5	1.75	2	2	1.5	0.6531	84.3
FH-SW2	15-Apr-13	0.7112			0.254	0.508		114.3	88.9		Rectangular	0.0729	1.0414	2.4	2.7	3	2.3	1.8	0.4268	27.4
			0.889					82.55	57.15		Rectangular	0.0605								
				0.8128				69.85	76.2		Rectangular	0.0595								

NOTES:
1) 'm' indicates metres.
2) 'mm' indicates millimetres.
3) 's' indicates seconds.
4) 'L' indicates litres.



LEGEND

SITE LOCATION

BH05-2 MONITORING WELL LOCATION AND DESIGNATION

1 km RADIUS FROM THE SITE

F SPRING ASSESSMENT POINT LOCATION AND DESIGNATION

SWB SURFACE WATER STATION LOCATION AND DESIGNATION

250 0 250 m

MAP SOURCE:
OBM 1:10000 MAPPING, NAD 83, ZONE 18.

SPRING ASSESSMENT - APRIL 2013

HYDROGEOLOGICAL STUDY
CODRINGTON PROPERTY
For St. Marys Cement Inc. (Canada)

DATE: APRIL 2013	SCALE: 1:25000
PROJECT: 111-52809-00 105	REF. NO.: 111-52809-00 105 F1-SP

GENIVAR

FIGURE C-1